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TITLE: THE IMAGERY OF PHYSICS IN PSYCHOLOGY: A PHYSICIST'S REACTIONS

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The Imagery of Physics in Psychology: A Physicist's Reactions

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I.

What could physics and psychology possibly have in common? Most physicists would immediately reply "nothing" and consider the matter closed. They would, of course, be considering overlaps of subject matter; the phenomena of physics and the phenomena of psychology. They would conclude almost immediately that there is no overlap except, perhaps, in the vain hopes of some important psychological thinkers of the turn of the century that eventually psychoanalysis might become obsolete, as a scientific and even mechanical basis for human behavior emerged. I will return to that heady era in both physics and psychology.

Physicists might grant that there is a relation between the subjects in that man does physics and so the doing of physics is a human activity worthy of consideration as a psychological activity. Having seen the spectrum of personalities involved in doing physics, I assure you that there is a rich field there, but that is not primarily what we are here to talk about this weekend. I think we are getting closer though.

We get even closer to a possible relationship by referring to the works of that seminal modern thinker, Woody Allen. In one of his films, his wife leaves him for another lover. The blow is amplified by the fact that she has left for a female lover. His friends are trying to introduce him to other women and he deals with this situation with his typical hysteria. He remarks, amidst this internal and external chaos, something like, "They're trying to get me to pull myself together and I've just read in the New York Times that physicists have just said that

matter is decaying!" Woody was referring, of course, to the recent interest in proton decay which, if confirmed* would mean that in some very long time (an incredibly long time) all ordinary matter as we know it would decay into lighter debris.

This is, then, a popular reflection that the picture of the world communicated to the lay public (we are, I am told, priests of a high cult of idolatry) is not a reassuring and comfortable one. Of course physicists have set out to uncover a certain kind of truth. In seeking truth, the chips must be allowed to fall where they may. This is a classical image of physics and one of the reasons our dialogue this weekend is so important.

Most physicists, given the proper explanation, would accept the assertion that the description of reality constructed by physics has had unsettling impacts on cultural psychology. This does not deflect physicists, because they believe deeply in the merit and validity of what they do. But physicists would certainly support the idea that a group of psychologists might meet for three days to confer about dealing with the psychological fallout of modern physics. When I first began to consider

*About one month ago, a Japanese team reported the observation of a candidate proton decay event. While this event is reported to be a near perfect example, not all physicists have accepted it. The reported lifetime of the proton from this observation should be about 2×10^{31} years.

this seminar, I was willing to grant this view as valid and worthy of discussion.

I may have been willing to go a bit further. I recall, as an undergraduate, that in the same year I studied quantum mechanics, I took Columbia University's marvelous sequence in Oriental Civilization. I was struck by some of the connections I sensed between modern physical theory and the great Hindu treatises. This connection has been the subject of several books during the last decade. Oriental thought and its similarity to modern physical ideas are getting even closer to our dialogue here.

II.

It was my reading of Roger Jones' "Physics As Metaphor" which really moved me beyond the simple view I just described, but only in abrupt lurches. I saw some striking new ideas, but I also reacted to his iconoclasm as excessive. I reacted strongly to his assertion (at least I took it this way) that the simplifying assumptions used by physicists have been built up into an idolatry thrust upon our culture as a whole, with ominous effect. I felt that physics, which concentrates on the most basic and universal physical problems and uses the simplest, most powerful definitions as a starting point, was being misrepresented. Some of my reaction was defensive, and some was based on incomplete understanding.

Jones moved too quickly, for me, to discussing the role of the human creative act as basic and prior to forming a picture of the external world. The notion that the world is fundamentally a human creation could not compete with the power I, as a physicist, grant to the idea of a physical reality out there. This is the idolatry which Jones talks about, of course. I accepted Jones' excess use of force as a possibly necessary destructive posture preliminary to fashioning some new and, presumably, superior picture. The mistake I made was not to have read Barfield first.

Barfield's "Saving the Appearances: A Study in Idolatry" is a powerful work. If I were still teaching at a University, I would urge all mature students of physics to read it. We do precisely what he calls

"alpha thinking," in that we think about the observations we make in fashioning "collective representations" or "saving the appearances." We rarely engage in "beta thinking" about our process, our method, or the foundations of our scientific approach. We are concerned with the confrontation of experimental (sense) data and our logical and mathematical (idols, images) explanation of the data.

Given this situation, physicists cannot hope to easily embrace radically new directions in doing physics. Of course, "beta thinking" took place, historically, when physicists were still called natural philosophers. Having come upon the "perfect" system, the empirical scientific method, we no longer needed philosophy and so discarded it. On balance, I don't think this has hurt the progress of modern physics. We have been able to achieve, in my view, wondrous advances in physical science by following this narrow path. I think we are mostly aware of the narrowness of the path and accept it, even enforce it, by forcefully avoiding competing and "irrelevant" approaches. There have been historical times in physics when our inability to "think about our thinking" has set us back. I think the resistance to accepting quantum theory and its probabilistic view by some, even eminent, physicists is a good example. It was faith in mathematical language, though, that bridged the gulf between the classical scheme and the modern picture. So the methods of physics have been entirely adequate to the venture.

I have not yet addressed Barfield's central message. His description of primitive (pre-scientific revolution) man's "original participation" in the tapestry of the world's phenomena is pivotal. This

cloak, in which primitive man wrapped himself, filled with totems and symbols which represented the underlying creative forces lurking just behind and beyond the symbols, enveloped him in what must have been a comfortable and reassuring reality. Thus, the phenomena had "meaning" in that they meant something. Barfield grants to physics as its highest achievement not the "Big Bang" or computers or field theory or space travel, but physics' destruction of the last vestiges of "original participation." Thus, we moved from "phenomena as meaning something" to "phenomena as independently valid themselves." This is, of course, an idolatry of a new sort to Barfield.

Did physics generate this motion or did the development of the scientific outlook merely reflect a general cultural advance? I think it would be hard to prove a causal connection, but it is clear that science promoted this advance through its own development and was, perhaps, the purest example of a revolutionary attention to external things.

With this move, and with the freedom which accompanied scientific knowledge, man's place lost its "meaning"; its old meaning, of course. The impact of physics is now so thorough that its view has come to us all. In Barfield's glossary, our "alpha thinking" about the phenomena led to our "collective representations," the shared and common thoughts about bare phenomena. This shared view is now so thorough that it has moved into "figuration," requiring no thinking about the phenomena anymore. Modern man approaches the world as a classical physicist does, on an intuitive level. The "images" of classical physics are "seen" by all.

It is the attempt to move beyond this to Barfield's "final participation" which is what I believe we are discussing. It is this transformation which, I suppose, some of you hope will bring out the positive, curative elements in human consciousness and which is what you hope to employ in doing psychology. However, I am not here to lecture to you about psychology. I want to give you my reactions to this call for a realization of man's role as a "creator" of his collective representations. This, then, would be a real move beyond the classical physicist's stance.

I misunderstood Jones' call for this leap forward as a repudiation of physics. In any sense that it is, within the domain reserved by physics, I reject it. I now take his broader call, and Barfield's, in a different sense. If I have to restate it, I would say that Barfield attributes to science the role of the agent, moving man from a view of phenomena as having "meaning" to phenomena as independent realities. We are now at a watershed point where we must all move to phenomena as crucially dependent on human consciousness. He calls this "final participation," but I am very comfortable with the word "imagination." I can accept this view as a statement about man, not about physics, which upon reflection should not be tampered with but recognized for what it is. Physics can certainly benefit from a heightened realization and awareness that it is a human activity and that its syntheses depend ultimately on human consciousness and imagination, deriving all their meaning only in a human context. I see no need for physics to change its methods, within its boundaries.

Humans must grow up, however. We must see science as a powerful, but narrow, endeavor. Scientists will not be hurt by this loss of status. We know that through prearranged narrowness we guarantee some success.

I was struck by the fact that Barfield quoted Sartre only in his final lines. While Barfield's work is original and new and different from the existentialist's contribution, its import amounts to nearly the same thing. I may be inviting spirited objections, but I see Sartre's emphasis on how we are here, alone, complemented with Barfield's clear statement of the human impact of a scientific world view, as together laying the foundation for a developing, collective reliance on human consciousness as a more valid source of "meaning." Barfield's parallel focus on the Jewish view of the creative force as "I am" gets very close to this. Physics is a useful tool, but it is in our hands.

Consider the image of the cosmic void. Who among us does not feel a shiver, a sense of being dwarfed, a yawning of the abyss, when contemplating the vast, empty universe? A neutron star collapses, a meteor strikes a planet; we subsist on a tiny speck. Does this sense lead to despair, a loss of old principles and sources of nourishment? What we must realize is that our perception of the void, of the vast vacuum, comes to us through ourselves. The cosmos speaks to us; we are dizzy as we imagine the expanse. We share this language of the outside and we interpret it. We are physicists.

So we must take our meaning from each other. I recognize this, not merely as "secular humanism," though on a day-to-day basis it might be hard to make the distinction. "Secular humanism" is the product of a romantic love of man as phenomenon himself in the same way that a romantic love of mountains, or nature, or the "environment" is thoroughly the working out of the classical physicist's world view. Each of these is a phenomenon valid and beautiful in itself. Humanity is one of these. I think what we are focussing on here is that human consciousness and imagination are not romantic phenomena, merely inexplicable with physics, but that human imagination is the source of meaning.

It is a great journey for most physicists to come to the point where one deals with the human frailty built into physical theory. We have a great deal of additional ground to cover, though. I'd like to consider the modern post-quantum mechanics physical picture and its possible relation to image psychology, the value and difficulties "imagination" offers to those concerned about a rush to nuclear extinction, how this transition might be accomplished abruptly and tragically or in a more reasoned and positive manner, and the role of science in shaping public policy. At the end of that ambitious list, I shall have played most of my cards and be ready to participate in your dialogue.

III.

Does modern physics offer something besides the old positivist idols? Does it contain elements which support the move to a more human-created picture of the world? I think that quantum theory contains a key element and has accomplished something which puts the ball in the human court. I assert that the development of physics in the last 50 years has moved increasingly in this direction. I don't know whether this is all just an intellectual curiosity, or whether it can have real and meaningful impact on human thought. I do believe that this direction has not been directly communicated to the non-physicist and so, to date, it has not had an opportunity to be incorporated into any general progress toward a new set of human metaphors. The indirect communication of these ideas is there in our art and music, but I am not sure this is sufficient. Let me be more specific.

In the classical physics which developed in the Renaissance and reached its zenith at the turn of the century, all of the foundations of positivism were laid and "original participation" was expunged from urban, Western man's consciousness. (This last set of modifiers is, I believe, of crucial importance to our discussion.)

When the classical physicist had before him the Newtonian equations of mechanics, Maxwell's equations for electricity and magnetism, and the masses, charges, and instantaneous positions and velocities and accelerations of all "particles" in any physical domain, all the behavior throughout all time (earlier and later) could in principle be calculated.

The resulting precision would be limited only by the accuracy of the initial information and one's persistence in calculating. This is a fully deterministic view and there is considerable evidence that, as classical physics was assembled (the last pieces were put in place in the late 19th century) scientists believed more and more in the power of this theory. While they were mostly religious men and carried conflicting views, this classical notion of the universe as "solved, in principle" gained nearly total acceptance. This is the purest form of Barfield's idolatry. One never had all the required input data, nor the calculational ability, so that most practical problems were still intractable. Nevertheless, all "ideal" cases were solved and all experiments were consistent with the theory. A young physicist at the turn of the century was likely told that physics was really a finished endeavor (except for a few trivial difficulties) and that he was to devote himself to calculating and measuring even more complex systems (atomic spectra, dielectric and magnetic properties of bulk matter. Eventually the few unsolved problems and the other great scientific fields (chemistry, biology, astronomy, psychology,...) would likely yield to physical insights.

A typical trivial difficulty was the so-called "radiation death" of the atom. Though there were other glitches in the system, this problem was an irascible one. Classical electrodynamics predicted that electrons orbiting in atoms should radiate electromagnetic waves which would carry off energy. While we could observe light coming off atoms in discrete spectral lines under some circumstances (atomic spectra), the continuous set of frequencies predicted was missing. Furthermore, the radiation

should carry off energy, leading the electron orbits to collapse. In a split second, all the atoms in the universe should collapse! On New Year's Eve, 1899, this difficulty was a thorn in the side of physics, but 20th century physicists awoke the next morning, assured that their basic model of physical nature was intact and essentially complete.

That thorn was a seed, of course, and the next three decades tore classical physical theory apart, leaving it only as a limiting case of a greater underlying picture.

The Bohr theory of the atom, the black body radiation problem, the duality of particles and waves, special relativity, general relativity, the uncertainty principle, quantum mechanics and, finally, the relativistic quantum theory of fields replaced the edifice of classical physics. Our intuitive sense of space, time, forces, and geometry was destroyed by relativity theory. Our intuitive sense that the mathematical logic of physics led to definite solutions was replaced by a theory in which what we measure can only be predicted as a probabilistic statement before the measurement, and that the system is always unalterably changed by our act of measurement. The world is not a shadow box, set neatly behind plate glass, for the physicist to admire and model with his mathematical language. He must break the glass and participate in it, if he is to know it at all.

The new physics makes the human the central determinant in all measurements of physical nature. The theory of physical laws developed from that time is concerned with the calculation and prediction of the

behavior of the combined "outer world-observer" system. External physical states (what Barfield calls the "unparticipated" phenomena) still exist in this theory and mathematical objects (wave functions or state vectors) are used to describe them. However, all human experience of these objective states is governed and limited by the act of measurement. The wave function contains all the information necessary to predict the probable result of a measurement of the system.

We must not be confused by the use of the word "observer" in the new physics. Measurements are performed by detectors, spectrometers and apparatus, non-sentient observers, and the characteristics of these tools are the ones put into the theory to calculate the likely results. The devices used are human creations, though. They are human concrete statement of the measurement we wish to make. The theory, however, limits the intimacy of the result and what humans may know ultimately. The break with classical physics in the new picture is genuinely a statement about human experience of physical phenomena.

This is a long way from the classical, totally determined, and totally described system. Without human measurement and, therefore, participation, the new physics is meaningless. Ordinary bulk phenomena familiar to pre-twentieth century man are still largely described by classical physics which, via the correspondence principle, is a limiting case contained within the new physics

Let me give a few examples of the perspective of quantum physics. You have all heard the irregular sequence of clicks uttered by a Geiger counter as it counts the products of radioactive decays of an unstable element. Given the classical description of matter, one would be able to calculate (given the required starting data and persistence) when each atom would decay and, presumably, the time interval between clicks. In fact, what one hears are clicks spaced randomly in time. Only the average number of clicks in a time interval can be calculated (and the "half-life" or average time in which half the remaining atoms will decay). The half-life can be calculated quite accurately for a large sample of matter. This is why classical physics always worked so well. It is a science of large ensembles of systems so it always involves these very accurate averages.

The development of the physics which provides the description of radioactive decays is the undoing of determinism. Do we assert that a random, probabilistic universe is a superior source of meaning than the determined, mechanical universe? That is not our intent at all; this should be clear from the complete discussion.

Another example I recall from my undergraduate days in the early 60's is Gerald Feinberg's lecture on tachyons. These are hypothetical particles (never observed) which always travel faster than the speed of light. In special relativity these particles would have a mass whose square is a <u>negative</u> number. They are therefore presumed forbidden, though many experimental searches for them have been carried out. If you postulate their existence, you can consider an experiment in which two

colleagues, Joe and Moe, each possessing a tachyon, agree to a plan. They will separate; Joe will emit his tachyon and when Moe's tachyon detector picks it up, he will emit his tachyon for Joe to detect. This is a simple plan, amounting to no more than a game of "catch". When you calculate this sequence using special relativity (these are very fast particles and may not be treated classically) you find that Joe's tachyon arrives at Moe's position, Moe emits his tachyon and it arrives at Joe before Joe has launched the first tachyon! Cause and effect, that bastion of determinism, has been struck down.

Modern quantum theory saves the day, but not by restoring cause and effect. In modern physics, we learn we can only consider the probability of Joe's emission of a tachyon and the probability of Moe's detection, and so on. Cause and effect are abandoned, and processes that are forbidden classically are permitted under certain unmeasurable circumstances (the Heisenberg Uncertainty Principle).

At best, I may have convinced you that modern physics is different. But is a random universe more reassuring than the objective universe? What is absolutely essential in the new picture is that we can only construct a theory of measurement probabilities. Thus, the unparticipated states are experienced only through "collective representations" a la Barfield. This is very close to the language of quantum theory. The key player in the modern game is human. The science is still mathematical, logical, and empirical. The old physical laws were relations between external physical variables. The new ones contain

mathematical operators which yield the likely results of our measurements. We construct the operators and apply them.

Modern physics has battered the monumental and impenetrable edifice of classical physics, which can never again be an obstacle to appreciating the human role in the creation of physics. In this sense, physics has become like other fields. The human act is in the doing of physics, and now we may focus on it.

The most modern theories have continued to travel this path. In our classical and modern search for the building blocks of matter, we have taken molecules apart into atoms and then removed the electrons and nuclei. The nuclei have been fragmented into protons and neutrons, bound by a meson glue. These mesons and nucleons consist of quarks bound by gluons according to current theory. The known pantheon of fundamental entities now consists of quarks and color gluons, leptons, photons, the weak bosons (discovered during 1983), the graviton, and perhaps something called the Higgs Particle. Recent theories postulate that some of these are composites of more basic objects or suggest other symmetric families of partner objects. The proliferation of the members of this minimal set of building blocks has brought despair to those who hoped for a simple, elegant, unity. One of the most modern views is to seek simple mathematical group structures to describe this zoo of elementary objects. A simple set of building blocks is replaced by a simple mathematical structure as the aim of theory building. A human thought object becomes the generator of physics. The language of physics, I am afraid, has incorporated this human-creative stance, at its very heart.

Let me go even further and tell you about the modern physicist's picture of the state of nothingness which we call the vacuum. This image is at the center of our discussion. In classical physics the vacuum is an empty region devoid of material objects and of any energy. Space in the vacuum is flat, empty and featureless. When we combine relativity and quantum theory to derive quantum field theory, especially if we include the electromagnetic field and gravity, we find that the vacuum is paradoxically rich and complex. As early as the 1930's, the vacuum was known to contain a sea of virtual particle states. These negative energy states were continually materializing or being raised (created) out of the vacuum and being lowered (annihilated) spontaneously back into the vacuum state. The energy of a region of vacuum is non-zero, in general, and the spontaneously emerging states described are never in existence long enough to be measured. They are hidden by the Heisenberg uncertainty principle. Real physical operations can be performed on the vacuum to create real states. The vacuum is rich and complex and is really the state of all potential states. In the most modern theories which incorporate gravity, the geometry of space is not uniform and featureless, but is curved and probably has a microscopically fine granular or cellular structure. This geometry of space and time is itself seething and bubbling and foaming and fluctuating spontaneously.

Even more astonishing is the idea (contributed to me by Geoffrey West) that we are all connected through the vacuum, because our own virtual states come out of it. The instant of creation of the Universe may itself be the result of a precipitous singular fluctuation in the vacuum, and the converse image of destruction is provided to us by the

spectacular phenomenon known as the black hole. The paradox, known for so long to Oriental mystics, of nothingness and everything embodied as one emerges from the mind of the twentieth century physicist. Though I have taken a great deal of liberty here, in abandoning the mathematical structures and the assumptions and caveats, in trying to give a qualitative description to you, I believe a more careful approach amounts to the same thing, in the end. Modern physics is very different from classical physics. The whole range of human imagination is employed in creating our image of the physical world.

IV.

Do these ideas mean that modern physics will, more and more, communicate to mankind a less positivist view and make way for a viewpoint in which man's imagination and participation are seen as central? I believe that the answer is a limited yes, amounting in our lifetime to an effective no. Even modern physicists, intellectually aware of all that physics says, mired in their alpha thinking, are stuck with the idolatry of classical physics. As Barfield points out, final participation only comes when the creative role of human consciousness becomes manifest in our "figuration." I am using his glossary, but the sense should be clear. Fifty years of modern physics has barely begun to move scientists. Do physicists feel they are <u>discovering</u> the laws of physics, or that they are <u>creating</u> better and more attractive physical pictures? How can we, then, hope to communicate this view to non-scientists? Is there any hope of reaching a unity of viewpoint with the vast portion of mankind, whose fingers quiver near, if not on, the nuclear trigger, and who are still stuck in primitive "original participation?"

The most depressing thing about our meeting this weekend is that the bulk of mankind, even the nuclear world, is hopelessly outside the framework we are discussing. Even those whom we may wish to bring out of the idolatry of positivism will not come quickly. What tools are at our disposal?

Art and music may be an effective way to communicate. I believe that, in fact, the historic transition from representational painting to abstract, non-representational forms is a reflection of the more modern viewpoint. Art historians may disagree, but the case of a late nineteenth century painter, working in a representational format, imitating the outside world as phenomenon is illustrative. Is not the transition within a few decades through impressionism, fauvism, and cubism not a parallel intellectual development, a freeing of the imagination, in the same manner that the turn of the century physicist was driven? The development of music from teleological, temporal classical and romantic forms into spatial, textural and discrete forms characteristic of atonal music is another reflection. Did physics drive these developments or have music art and physics all participated in a general cultural advance?

Yet, mass reactions to modern art forms focus on the destructive (towards older forms) aspects. Modern art forms are unsettling. This is part of the historical pattern which always begins with an attack on old images. I will return to the matter of instability accompanying cultural advances.

Education may reach an intellectual vanguard and this may contribute. At this point, I am left with no other efficient alternatives. Street theater, new political strategies and methods, and the like offer little hope. New technologies generally require a human generation for wide dispersal (and only in developed nations). New world views may take a century or more again only capturing the leading

segments of civilization. The nuclear- capable Khomeinis and Quaddafis are still cloaked thoroughly in that medieval tapestry.

What I am trying to say is that I think we have identified a useful and even crucial cultural change which would lead to a healthier world, certainly one less oppressed by an ominous tension. However, I see no timely way to bring the patient to that point at which suicide is not the ultimate r[illegible] rom this tension. I do not see appropriate means for those portions [illegible]umanity most amenable to this treatment, nor do I think what many of us are discussing is applicable to vast portions of the world's peoples. This may be a despairing view, but if one is not realistic in assessing the most grievous problems, one makes the most grievous errors

In fact, I can even consider a way one might argue for going slowly. The world is in a tense condition of instability. The balance has held during my lifetime in the most significant ways. If the scientific view of physical reality has contributed not merely the technical means to set up this terrible balance, but also the psychological precursors which encourage man to dance close to the edge, can science remedy this situation? Is there any way to effect the desired changes and remain in a stable condition in the transition?

A calamity may result if tensions build to the point where the suicidal or homicidal exit is attractive. In the developed world, one may increase tensions if, in the process of cultural change, one excites

these tensions by iconoclasm. I don't see how to do this, but history shows that most great cultural advances are accompanied by upheaval.

What we really want is a gradual awakening to the central role of mankind as the source of meaning. This slow process may be stable, but may not make a difference in time.

Physicists may be able to contribute in some ways to the reeducation of humanity, but the real process lies outside of physics, and is even independent of physics. Creating an awareness of the creative role of insight and imagination does not require abandoning the figuration of positivism. There is a physical reality out there. The two (phenomena vs human consciousness) are not antithetical; one is merely missing now as the source of meaning. We cannot retreat into ourselves. Phenomena and things are out there beyond us; in knowing them we participate in them. Isn't this Barfield's "final participation."

The possibility of suicide has always been there, yet most of us do not try it. We, individually, have learned to live with the proximity of annihilation. Now we have the prospect of the "second death of mankind" as a possibility. We don't take our lives because, individually, we value and find meaning in our life. The same positive factors must keep us from mass suicide.

We must do this because the idea of the nuclear weapon will always be with us, even if the physical weapons could be destroyed. This is

what Giegerich has said at the recent "Facing Apocalypse" conference. We must learn to live in the post-nuclear world.

I don't see how a material world view, a gift of science, must be fatal I do see the need for a greater sense of the value and meaning of humanity in general. I see that this sense should be more prominent in determining our "collective representations" and eventually our "figuration." Human consciousness and imagination must be the wellspring of our morality and the value of our living.

Science will never provide these things. Science may answer questions such as the age of the universe, but it will never give the universe value or meaning. Science, itself, has no meaning without us. It has been called "the glorious entertainment" by Jacques Barzun. Science may have changed our world view more than art or music or poetry (I'm not sure about this, though) but if it has, it must be because its subject has some measure of independent permanence and reality.

While I think there is value in studying the oriental view and its denial of much of material reality, I don't believe that is the answer. In the same way that iconoclasm may be a useful way to force the intelligentsia to momentarily retreat from positivism, adopting oriental views may be a useful transitional device. The proper end result, though, is the development, collectively, of reliance upon ourselves and our participation in the physical world. Denial of the outside is not needed. In the final analysis, the oriental viewpoint may be alternative or complementary, but it is incomplete, as is the positivist idolatry.

V.

Let me spend a few moments talking about the public role of scientists. In moving toward an increasing awareness of the role of human imagination, science, and its broad public appeal to the last generation, may continue to be an obstacle. This is what some of you mean when you criticize the current peace movement or other citizen movements. Science has provided many powerful capabilities and solutions to mankind's problems during this century. It has been elevated to a status far beyond its merit. Science has enjoyed such a high credit rating that often social debates are won merely by appeal to a scientific or technical argument. There is some value to this technique, but not if the human heart of the issue is lost or discarded.

A graphic example of the role of science in public policy issues was played out last spring at the 40th anniversary celebration at the Los Alamos National Laboratory. One of the events was a panel discussion, before a large audience, on arms control, the nuclear freeze, and the new generation of high technology weapons advocated by the President. The panelists were a distinguished group in weapons science. Edward Teller was there, presumably to advocate a point of view for which he is well known. Don Kerr, the Director of the Laboratory, again presumably, would speak in a more pragmatic and institutional mode. The other two panelists were two of the most distinguished arms control scientists in America, Nobelist Hans Bethe, and Richard Garwin. These two men, with impeccable scientific and arms-control records, are the epitome of the establishment arms-control movement. Their effectiveness comes from

their extraordinary ability to present simple, clear, consistent technical calculations and policy analyses which show that many new weapons systems will not perform as advertised, will not produce the desired strategic effect, and will likely make the world a more dangerous place. They are so good at what they do that they are accorded the highest government clearances and frequently consulted by the Defense Department and DOE for their devil's-advocate analyses.

Before I leave this panel discussion, let me say that the latter two represent an approach to arms control which is the source of some criticism of the current peace movement. Some of the most successful arms control advocates, by their methods and chosen tools, are indistinguishable from weapons scientists. This fact has generated the criticism that the peace movement has moved closer to the mental state of weapons advocates, instead of in other directions. The criticism is valid in spirit and in fact, but mankind's attempt to deal with the threat of global annihilation is too important to permit abandoning any tools. We must base our values and choices on human considerations, but in the struggle to create a viable post-nuclear world, I don't know who will contribute more in the end: a Hans Bethe or, say, a Robert Jay Lifton.

The panel discussion, by the diversity, balance, and abilities of the panelists, held out the hope that a preponderance of the technical discussion might come down on one side or another of the issues. What unfolded were four very convincing technical and policy presentations along more or less the expected directions. Any one of the speakers

would have been extraordinarily effective had he been alone on stage. The combination of so much technical expertise and carefully crafted logic, leading to three or four very different sets of conclusions, nearly wiped out the effectiveness of all four. Their differences were the result of value judgments made by each as an individual person, not as a scientist. In fact, the Laboratory Director was the speaker most cognizant of the role of the scientist as servant of the human policy makers. The political process generates policy goals towards which the scientist is requested to provide vehicles.

The underlying message was that scientific studies are inadequate tools in the search for the answers to essentially human dilemmas. They may be useful tools, and the peace movement (and the military establishment as well) uses them, as do environmentalists, consumerists, and others. The best possible answers must come from human perspectives. This is what I think some of you are talking about. We have all been too eager to think like physicists and to ask them for answers to big problems. What we must do is prevent the use of science as an obstacle to imagination. Conversely, we must be careful to call upon science for those things which it can address.

While I may have agreed with Barfield and Jones and Capra and my colleagues up here on the psychological and epistemological arguments and while I have admitted to the role of classical and modern physics, I am afraid I have not been very encouraging on the matter of translating these considerations into mass changes in cultural psychology, or group therapeutic answers to social difficulties, or even to simple political observations. Fortunately, our meeting this weekend is a dialogue, not a